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CP Weesp (NL). **VAN STUIVENBERG, Herman, H.**  
[NL/NL]; Solvay Pharmaceuticals B.V., c/o C.J. van  
Houtenlaan 36, NL-1381 CP Weesp (NL).

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(74) Agent: **MUIS, Maarten**; OCTROOIBUREAU ZOAN  
B.V., P.O. Box 140, NL-1380 AC Weesp (NL).

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(71) Applicant (*for all designated States except US*): **SOLVAY  
PHARMACEUTICALS B.V.** [NL/NL]; C.J. van Houten-  
laan 36, NL-1381 CP Weesp (NL).

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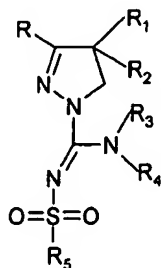
(75) Inventors/Applicants (*for US only*): **KRUSE, Cornelis,  
G.** [NL/NL]; Solvay Pharmaceuticals B.V., c/o C.J. van  
Houtenlaan 36, NL-1381 CP Weesp (NL). **LANGE, Jose-  
phus, H.M.** [NL/NL]; Solvay Pharmaceuticals B.V., c/o  
C.J. van Houtenlaan 36, NL-1381 CP Weesp (NL). **TIP-  
KER, Jacobus** [NL/NL]; Solvay Pharmaceuticals B.V.,  
c/o C.J. van Houtenlaan 36, NL-1381 CP Weesp (NL).  
**HERREMANS, Arnoldus, H.J.** [NL/NL]; Solvay Phar-  
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(54) Title: NOVEL 4,5-DIHYDRO-1H-PYRAZOLE DERIVATIVES HAVING CB1-ANTAGONISTIC ACTIVITY



(I)

(57) Abstract: The present invention relates to a group of novel 4,5-dihydro-1H-pyrazole deriva-  
tives which are potent cannabinoid (CB1) receptor antagonists with utility for the treatment of  
diseases connected with disorders of the cannabinoid system. The compounds have the general  
formula (I) wherein the symbols have the meanings given in the specification. The invention also  
relates to methods for the preparation of these compounds, and to pharmaceutical compositions  
containing one or more of these compounds as an active component.

Novel 4,5-dihydro-1H-pyrazole derivatives having CB<sub>1</sub>-antagonistic activity

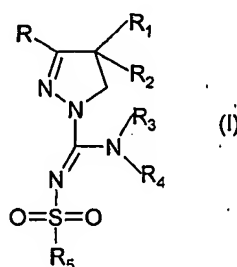
The present invention relates to a group of novel 4,5-dihydro-1H-pyrazole derivatives, to methods for the preparation of these compounds, and to pharmaceutical compositions containing one or more of these compounds as an active component.

The above mentioned 4,5-dihydro-1H-pyrazoles are potent cannabinoid (CB<sub>1</sub>) receptor antagonists with utility for the treatment of diseases connected with disorders of the cannabinoid system.

Cannabinoids are present in the Indian hemp *Cannabis sativa* and have been used as medicinal agents for centuries (Mechoulam, R. and Feigenbaum, J.J. *Prog. Med. Chem.* **1987**, 24, 159). However, only within the past ten years the research in the cannabinoid area has revealed pivotal information on cannabinoid receptors and their (endogenous) agonists and antagonists. The discovery and the subsequent cloning of two different subtypes of Cannabinoid receptors (CB<sub>1</sub> and CB<sub>2</sub>) stimulated the search for novel cannabinoid receptor antagonists (Munro, S. *et al.*, *Nature* **1993**, 365, 61. Matsuda, L.A. and Bonner, T.I. *Cannabinoid Receptors*, Pertwee, R.G. Ed. **1995**, 117, Academic Press, London). In addition, pharmaceutical companies became interested in the development of cannabinoid drugs for the treatment of diseases connected with disorders of the cannabinoid system (Consroe, P. *Neurobiology of Disease* **1998**, 5, 534. Pop, E. *Curr. Opin. In CPNS Investigational Drugs* **1999**, 1, 587. Greenberg, D.A. *Drug News Perspect.* **1999**, 12, 458. Pertwee, R.G., *Progress in Neurobiology* **2001**, 63, 569). Hitherto, several CB<sub>1</sub> receptor antagonists are known. Sanofi disclosed their diarylpyrazole congeners as selective CB<sub>1</sub> receptor antagonists. A representative example is SR-141716A (Dutta, A.K. *et al.*, *Med. Chem. Res.* **1994**, 5, 54. Lan, R. *et al.*, *J. Med. Chem.* **1999**, 42, 769. Nakamura-Palacios, E.M. *et al.*, *CNS Drug Rev.* **1999**, 5, 43). CP-272871 is a pyrazole derivative, like SR141716A, but less potent and less CB<sub>1</sub> receptor subtype-selective than SR141716A (Meschler, J. P. *et al.*, *Pharmacol.* **2000**, 60, 1315). Aminoalkylindoles have been disclosed as CB<sub>1</sub> receptor antagonists. A representative example is lodopravadoline (AM-630), which was introduced in 1995. AM-630 is a moderately active CB<sub>1</sub> receptor antagonist, but sometimes behaves as a weak partial agonist (Hosohata, K. *et al.*, *Life Sc.* **1997**, 61, PL115). Researchers from Eli Lilly described aryl-aroil substituted benzofurans as selective CB<sub>1</sub> receptor antagonists (e.g. LY-320135) (Felder, C.C. *et al.*, *J. Pharmacol. Exp. Ther.* **1998**, 284, 291). 3-Alkyl-5,5'-diphenylimidazolidinediones were described as cannabinoid receptor ligands, which were indicated to be cannabinoid antagonists (Kanyonyo, M. *et al.*, *Biorg. Med.Chem. Lett.* **1999**, 9, 2233). Aventis Pharma claimed diarylmethyleneazetidine analogs as CB<sub>1</sub> receptor antagonists (Mignani, S. *et al.*, Patent FR 2783246, 2000; *Chem. Abstr.* **2000**, 132, 236982). Tricyclic pyrazoles were claimed by Sanofi-Synthelabo as CB<sub>1</sub> antagonists (Barth, F. *et al.*, *Chem. Abstr.* **2001**, 134, 340504). Interestingly, many CB<sub>1</sub> receptor antagonists have been

reported to behave as inverse agonists *in vitro* (Landsman, R.S. *et al.*, *Eur. J. Pharmacol.* **1997**, 334, R1). Reviews provide a nice overview of the cannabinoid research area (Mechoulam, R. *et al.*, *Prog. Med. Chem.* **1998**, 35, 199. Lambert, D.M. *Curr. Med. Chem.* **1999**, 6, 635. Mechoulam, R. *et al.*, *Eur. J. Pharmacol.* **1998**, 359, 1. Williamson, E. M., and Evans, F. J. *Drugs* **2000**, 60, 1303. Pertwee, R. G. *Addiction Biology* **2000**, 5, 37. Robson, P. *Br. J. Psychiatry* **2001**, 178, 107. Pertwee, R. G. *Prog. Neurobiol.* **2001**, 63, 569. Goya, P; Jagerovic, N. *Exp. Opin. Ther. Patents* **2000**, 10, 1529. Pertwee, R. G. *Gut* **2001**, 48, 859).

- 10 It has now surprisingly been found that potent and selective antagonism of cannabinoid-CB<sub>1</sub> receptors is present in the novel 4,5-dihydro-1H-pyrazole derivatives of the formula (I), prodrugs thereof, tautomers thereof and salts thereof



15

wherein

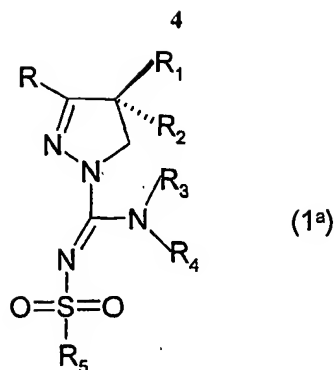
- R and R<sub>1</sub> independently represent phenyl, thienyl or pyridyl which groups may be substituted with 1, 2, 3 or 4 substituents Y, which can be the same or different, from the group C<sub>1-3</sub>-alkyl or alkoxy, hydroxy, halogen, trifluoromethyl, trifluoromethylthio, trifluoromethoxy, nitro, amino, mono- or dialkyl (C<sub>1-2</sub>)-amino, mono- or dialkyl (C<sub>1-2</sub>)-amido, (C<sub>1-3</sub>)-alkyl sulfonyl, dimethylsulfamido, C<sub>1-3</sub>-alkoxycarbonyl, carboxyl, trifluoromethylsulfonyl, cyano, carbamoyl, sulfamoyl and acetyl, or R and/or R<sub>1</sub> represent naphthyl,
  - R<sub>2</sub> represents hydrogen, hydroxy, C<sub>1-3</sub>-alkoxy, acetyloxy or propionyloxy,
  - 25 - R<sub>3</sub> represents a hydrogen atom or a branched or unbranched C<sub>1-8</sub> alkyl group or a C<sub>3-7</sub> cycloalkyl group which alkyl group or cycloalkyl group may be substituted with a hydroxy group,
  - R<sub>4</sub> represents a C<sub>2-10</sub> branched or unbranched heteroalkyl group, C<sub>3-8</sub> non-aromatic heterocycloalkyl group or C<sub>4-10</sub> non-aromatic heterocycloalkyl-alkyl group which groups contain one or more heteroatoms from the group (O, N, S) or a -SO<sub>2</sub>- group, which C<sub>2-10</sub> branched or unbranched heteroalkyl group, C<sub>3-8</sub> non-aromatic heterocycloalkyl group or C<sub>4-10</sub> non-aromatic heterocycloalkyl-alkyl group may be substituted with a keto group, trifluoromethyl group, C<sub>1-3</sub> alkyl group, hydroxy, amino, monoalkylamino, or dialkylamino group or a fluoro atom,
  - 30 or R<sub>4</sub> represents an amino, hydroxy, phenoxy or benzyloxy group, or R<sub>4</sub> represents a C<sub>1-8</sub> alkoxy, C<sub>3-8</sub> alkenyl, C<sub>5-8</sub> cycloalkenyl or C<sub>6-9</sub> cycloalkenylalkyl
- 35

- group which groups may contain a sulphur, nitrogen or oxygen atom, a keto group or  $-\text{SO}_2-$  group, which alkoxy, alkenyl and cycloalkenyl groups may be substituted with a hydroxy group, a trifluoromethyl group, an amino group, a monoalkylamino group or dialkylamino group or a fluoro atom, or  $\text{R}_4$  represents a
- 5  $\text{C}_{2-5}$  alkyl group which alkyl group contains a fluoro atom, or  $\text{R}_4$  represents an imidazolylalkyl group, benzyl, pyridylmethyl, phenethyl or thienyl group, or  $\text{R}_4$  represents a substituted phenyl, benzyl, pyridyl, thienyl, pyridylmethyl or phenethyl group wherein the aromatic rings are substituted with 1, 2 or 3 of the substituents Y, wherein Y has the meaning as indicated above,
- 10 or when  $\text{R}_3$  is H or methyl,  $\text{R}_4$  may represent a group  $\text{NR}_6\text{R}_7$  wherein
- $\text{R}_6$  and  $\text{R}_7$  are the same or different and represent  $\text{C}_{2-4}$  alkyl,  $\text{C}_{2-4}$  trifluoroalkyl or  $\text{R}_6$  represents a methyl group with the proviso that  $\text{R}_7$  represents a  $\text{C}_{2-4}$  alkyl group, or  $\text{R}_6$  and  $\text{R}_7$  - together with the nitrogen atom to which they are bonded - form a saturated or unsaturated heterocyclic moiety having 4 to 8 ring
  - 15 atoms which heterocyclic moiety may contain an oxygen or sulphur atom or a keto group or  $-\text{SO}_2-$  group or an additional nitrogen atom, which saturated or unsaturated heterocyclic moiety may be substituted with a  $\text{C}_{1-4}$  alkyl group, or
  - $\text{R}_3$  and  $\text{R}_4$  together with the nitrogen atom to which they are bonded form a saturated or unsaturated, monocyclic or bicyclic heterocyclic moiety having 4 to
  - 20 10 ring atoms, which heterocyclic moiety may contain one or more atoms from the group (O, N, S) or a keto group or  $-\text{SO}_2-$  group, which moiety may be substituted with a  $\text{C}_{1-4}$  alkyl, hydroxyalkyl, phenyl, thienyl, pyridyl, amino, monoalkylaminoalkyl, dialkylaminoalkyl, monoalkylamino, dialkylamino, aminoalkyl, azetidiny, pyrrolidinyl, piperidinyl or hexahydro-1H-azepinyl group,
  - 25 -  $\text{R}_5$  represents benzyl, phenyl, thienyl or pyridyl which may be substituted with 1, 2, 3 or 4 substituents Y, wherein Y has the meaning as indicated above, which can be the same or different, or  $\text{R}_5$  represents  $\text{C}_{1-8}$  branched or unbranched alkyl,  $\text{C}_{3-8}$  alkenyl,  $\text{C}_{3-10}$  cycloalkyl,  $\text{C}_{5-10}$  bicycloalkyl,  $\text{C}_{6-10}$  tricycloalkyl or  $\text{C}_{5-8}$  cycloalkenyl or  $\text{R}_5$  represents naphthyl.

30

At least one centre of chirality is present (at the  $\text{C}_4$  position of the 4,5-dihydro-1H-pyrazole moiety) in the compounds of the formula (I). The invention relates both to racemates, mixtures of diastereomers and the individual stereoisomers of the compounds having formula (I). Particular compounds of interest of formula (I) have

35 the absolute stereoconfiguration at the  $\text{C}_4$  position of the 4,5-dihydro-1H-pyrazole moiety as represented by formula (1<sup>a</sup>).



The invention also relates both to the E isomer, Z isomer and E/Z mixtures of compounds having formula (I).

5

The compounds of the invention can be brought into forms suitable for administration by means of usual processes using auxiliary substances and/or liquid or solid carrier materials.

- 10 Due to the potent CB<sub>1</sub> antagonistic activity the compounds according to the invention are suitable for use in the treatment of psychiatric disorders such as psychosis, anxiety, depression, attention deficits, memory disorders, cognitive disorders, appetite disorders, obesity, addiction, appetite, drug dependence and neurological disorders such as neurodegenerative disorders, dementia, dystonia, muscle
- 15 spasticity, tremor, epilepsy, multiple sclerosis, traumatic brain injury, stroke, Parkinson's disease, Alzheimer's disease, epilepsy, Huntington's disease, Tourette's syndrome, cerebral ischaemia, cerebral apoplexy, craniocerebral trauma, stroke, spinal cord injury, neuroinflammatory disorders, plaque sclerosis, viral encephalitis, demyelination related disorders, as well as for the treatment of pain disorders,
- 20 including neuropathic pain disorders, and other diseases involving cannabinoid neurotransmission, including the treatment of septic shock, glaucoma, cancer, diabetes, emesis, nausea, asthma, respiratory diseases, gastrointestinal disorders, gastric ulcers, diarrhoea and cardiovascular disorders.

- 25 The affinity of the compounds of the invention for cannabinoid CB<sub>1</sub> receptors was determined using membrane preparations of Chinese hamster ovary (CHO) cells in which the human cannabinoid CB<sub>1</sub> receptor is stably transfected in conjunction with [<sup>3</sup>H]CP-55,940 as radioligand. After incubation of a freshly prepared cell membrane preparation with the [<sup>3</sup>H]-ligand, with or without addition of compounds of the
- 30 invention, separation of bound and free ligand was performed by filtration over glassfiber filters. Radioactivity on the filter was measured by liquid scintillation counting.

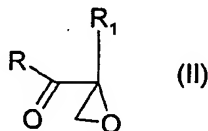
- The cannabinoid CB<sub>1</sub> antagonistic activity of compounds of the invention was
- 35 determined by functional studies using CHO cells in which human cannabinoid CB<sub>1</sub>

receptors are stably expressed. Adenylyl cyclase was stimulated using forskolin and measured by quantifying the amount of accumulated cyclic AMP. Concomitant activation of CB<sub>1</sub> receptors by CB<sub>1</sub> receptor agonists (e.g. CP-55,940 or (R)-WIN-55,212-2) can attenuate the forskolin-induced accumulation of cAMP in a concentration-dependent manner. This CB<sub>1</sub> receptor-mediated response can be antagonised by CB<sub>1</sub> receptor antagonists such as the compounds of the invention.

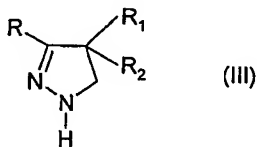
Intermediates having formula (II) (see below) can be obtained according to methods known, for example: a) Francotte, E. and Tong, Z. *Chem. Abstr.* **126**, 213598; b) Rempfler, H. and Kunz, W. *Chem. Abstr.* **113**, 40432; c) Rempfler, H. and Kunz, W. *Chem. Abstr.* **107**, 217473.

Intermediates having formula (III) (see below), wherein R<sub>2</sub> represents hydrogen can be obtained according to methods known, for example: a) EP 0021506; b) DE 2529689; c) Grosscurt, A.C. *et al.*, *J. Agric. Food Chem.* **1979**, 27, (2), 406.

Intermediates having formula (III) (see below), wherein R<sub>2</sub> represents a hydroxy group can be obtained by reacting of a compound having formula (II)



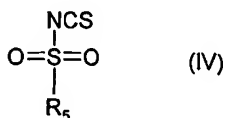
with hydrazine or hydrazine hydrate. This reaction is preferably carried out in an organic solvent, for example ethanol, and yields a compound having formula (III)



Suitable synthetic routes for the compounds of the invention are the following:

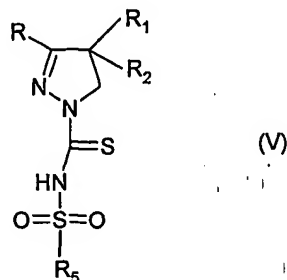
#### Synthetic route A1

Step 1: reaction of a compound having formula (III) with a thioisocyanate derivative having formula (IV),





preferably carried out in an organic solvent, for example acetonitrile. This reaction gives a thiocarboxamide derivative having formula (V), wherein R, R<sub>1</sub>, R<sub>2</sub> and R<sub>5</sub> have the meanings as described above for compound (I).



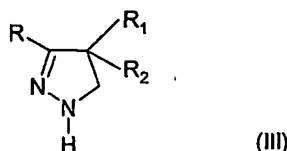
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Step 2: reaction of a compound having formula (V) with a compound R<sub>3</sub>R<sub>4</sub>NH in the presence of a mercury(II) salt, such as for example HgCl<sub>2</sub>, gives a compound having formula (I). This reaction is preferably carried out in an organic solvent, such as for example acetonitrile.

10

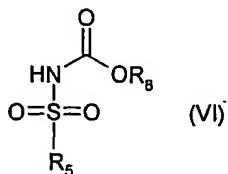
### Synthetic route A2

Step 1: reaction of a compound having formula (III)



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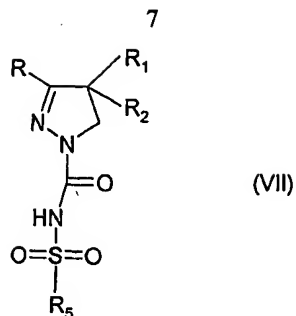
with a carbamate ester derivative having formula (VI).



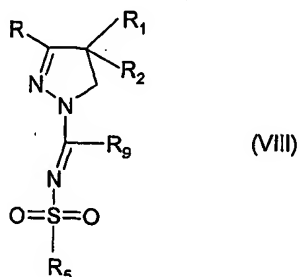
20

wherein R<sub>8</sub> represents a lower alkyl group, for example methyl. This reaction is preferably carried out in an organic solvent, for example 1,4-dioxane, and yields a 4,5-dihydropyrazole-1-carboxamide derivative having formula (VII), wherein R, R<sub>1</sub>, R<sub>2</sub> and R<sub>5</sub> have the meanings as described above for compound (I).

25



- 5 Step 2: reaction, preferably carried out in an inert organic solvent, for example chlorobenzene, of a compound having formula (VII) with a halogenating agent such as  $\text{PCl}_5$ , gives a 4,5-dihydropyrazole-1-carboximidoyl halogenide derivative having formula (VIII) wherein R,  $R_1$ ,  $R_2$ ,  $R_5$  have the meanings as described above for compound (I) and wherein  $R_9$  represents a halogen atom, for example Cl.

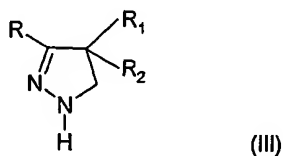


- 10 Step 3: reaction of a compound having formula (VIII) with a compound  $\text{R}_3\text{R}_4\text{NH}$ , preferably carried out in an inert organic solvent, such as for example dichloromethane gives a compound having formula (I).

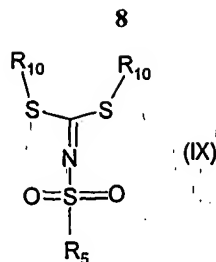
- 15 Alternatively, compounds  $\text{R}_3\text{R}_4\text{NH}$  which contain an additional nucleophilic nitrogen atom are reacted with a compound having formula (VIII) in such a way that the abovementioned additional nucleophilic nitrogen atom is protected by a protective group, for example a t-butoxycarbonyl (Boc) group and the like. Subsequent removal of the protective group according to known methods yields a compound having  
20 formula (I). (See for example: T.W. Greene and P.G.M. Wuts, "Protective Groups in Organic Synthesis", third edition, John Wiley & Sons, Inc., New York, 1999).

### Synthetic route A3

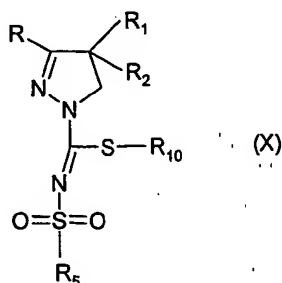
- 25 Step 1: reaction of a compound having formula (III)



with a dithioimidocarbonic ester derivative having formula (IX) .



- wherein  $R_{10}$  represents a  $C_{1-3}$  alkyl group. This reaction is preferably carried out in an organic solvent, for example acetonitrile or toluene, and yields a carboximidothioic ester derivative having formula (X), wherein  $R$ ,  $R_1$ ,  $R_2$ ,  $R_5$  have the meanings as described above for compound (I) and wherein  $R_{10}$  represents a  $C_{1-3}$  alkyl group.



- Alternatively, a compound having formula (X) can be obtained from the reaction of a compound having formula (V) with a compound  $R_{10}-X$ , wherein  $X$  represents a leaving group such as an iodide group, and  $R_{10}$  has the meaning as described above for (X).
- Step 2:** Reaction, preferably carried out in an organic solvent, such as methanol, of a compound having formula (X) with a compound  $R_3R_4NH$  gives a compound having formula (I).

The preparation of the compounds is illustrated in the following examples.

#### Example 1

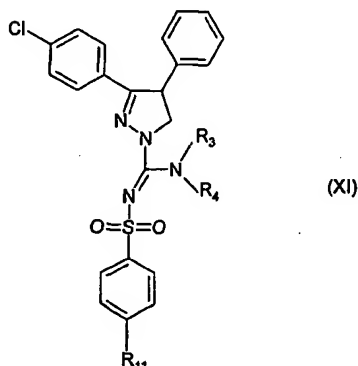
#### 3-(4-Chlorophenyl)-N'-((4-chlorophenyl)sulfonyl)-N-(piperidin-1-yl)-4-phenyl-4,5-dihydro-1H-pyrazole-1-carboxamidine

- Part A:** To a solution of N-((4-chlorophenyl)sulfonyl)carbamic acid methyl ester (CAS: 34543-04-9) (2.99 gram, 12.0 mmol) and pyridine (4 mL) in 1,4-dioxane (20 mL) is added 3-(4-chlorophenyl)-4-phenyl-4,5-dihydro-1H-pyrazole (3.39 gram, 13.2 mmol) and the resulting mixture is stirred for 4 hours at 100 °C. After concentration *in vacuo* the residue is dissolved in dichloromethane, successively washed with water, 1N HCl and water, dried over anhydrous  $Na_2SO_4$ , filtered and concentrated *in vacuo* to a volume of 20 mL. Methyl-*tert*-butyl ether (60 mL) is added and the resulting solution is concentrated to a volume of 20 mL. The formed crystals are collected by filtration and recrystallised from methyl-*tert*-butyl ether to give 3-(4-chlorophenyl)-N-((4-

chlorophenyl)sulfonyl)-4-phenyl-4,5-dihydro-1H-pyrazole-1-carboxamide (4.75 gram, 76 % yield) Melting point: 211-214 °C.

**Part B:** A mixture of 3-(4-chlorophenyl)-N-((4-chlorophenyl)sulfonyl)-4-phenyl-4,5-dihydro-1H-pyrazole-1-carboxamide (1.42 gram, 3.00 mmol) and phosphorus pentachloride (PCl<sub>5</sub>) (0.63 gram, 3.03 mmol) in chlorobenzene (15 mL) is heated at reflux temperature for 1 hour. After thorough concentration *in vacuo*, the formed 3-(4-chlorophenyl)-N-((4-chlorophenyl)sulfonyl)-4-phenyl-4,5-dihydro-1H-pyrazole-1-carboximidoyl chloride is suspended in dry dichloromethane (30 mL) and reacted with 1-aminopiperidine (1.08 mL, 10.0 mmol). After stirring at room temperature for 16 hours, the mixture is twice washed with water and concentrated *in vacuo*. The residue is crystallised from methyl-t-butyl ether (MTBE) to give pure 3-(4-chlorophenyl)-N'-((4-chlorophenyl)sulfonyl)-N-(piperidin-1-yl)-4-phenyl-4,5-dihydro-1H-pyrazole-1-carboxamide (0.57 gram, 34 % yield). Melting point (MP): 213-214 °C. MS ESI<sup>+</sup>: 556 (MH<sup>+</sup>).

Analogous to the synthesis of example 1, in total 57 compounds having formula (XI) were prepared. Those are listed below in table 1 and list 1.



20 **Table 1**

Ex.	R <sub>3</sub>	R <sub>4</sub>	R <sub>11</sub>	Melting point (°C)	MS ESI <sup>+</sup> (MH <sup>+</sup> )	Salt form
2	H	Piperidin-1-yl	F	189-190	540	
3	H	Pyrrolidin-1-yl	Cl	190-195	542	
4	H	Pyrrolidin-1-yl	F		526	
5	H	azepan-1-yl	Cl	197-199		
6	H	Cis/trans-2,6-dimethylpiperidin-1-yl	Cl	110-146		
7	H	2,2,2-Trifluoroethylamino	Cl	149-151		
8	H	t-Butoxy	Cl	194-196	545	
9	H	2-Propoxy	Cl	142-145		
10	H	Methoxy	Cl		503	
11	H	Methoxy	F		487	
12	H	Morpholin-4-yl	Cl	213-216		
13	H	2-(Morpholin-4-yl)ethyl	Cl	137-139		
14	H	2-(Piperidin-1-yl)ethyl	Cl	168-169		

15	H	2-(Pyrrolidin-1-yl)ethyl	Cl	155-157		
16	H	2-(Dimethylamino)ethyl	F			
17	CH <sub>3</sub>	2-(Dimethylamino)ethyl	Cl	168-170		.HCl
18	H	2-(Dimethylamino)ethyl	Cl	63-68		
19	H	2-(Methylamino)ethyl	Cl		530	.HCl
20	H	2-(Ethylamino)ethyl	Cl		544	.HCl
Ex.	R <sub>3</sub>	R <sub>4</sub>	R <sub>11</sub>	Melting point (°C)	MS ESI <sup>+</sup> (MH <sup>+</sup> )	Salt form
21	H	3-(Dimethylamino)-2-methylprop-2-yl	Cl		572	
22	H	(N-Methylpyrrolidin-2-yl)methyl	Cl	149-159		
23	H	(N-Methylpyrrolidin-3-yl)methyl	Cl		570	
24	H	4-(Pyrrolidin-1-yl)butyl	Cl	128-130	598	
25	H	3-(Morpholin-4-yl)propyl	Cl			
26	H	3-(Dimethylamino)propyl	Cl	221-224	558	.HCl
27	CH <sub>3</sub>	3-(Dimethylamino)propyl	F	93 (dec.)	556	.HCl
28	C <sub>2</sub> H <sub>5</sub>	2-Aminoethyl	Cl			
29	H	3-(Dimethylamino)propyl	F	105-109	542	.HCl
30	H	3-(1H-Imidazol-1-yl)propyl	Cl			
31	H	2-Aminoxyethyl	Cl		532	
32	H	2-(Dimethylamino)ethoxy	Cl	201	560	
33	H	2-(Diethylamino)ethoxy	Cl	210	588	
34	H	2-(Methoxy)ethyl	Cl	99-102		
35	CH <sub>3</sub>	2-(Acetoxy)ethyl	Cl	157-158	573	
36	H	2-Hydroxyethyl	F		501	
37	H	2-Hydroxyethyl	Cl		517	
38	H	2-Hydroxy-2-methylpropyl	Cl			
39	H	3-Hydroxypropyl	Cl	129-132		
40	CH <sub>3</sub>	Hydroxy	Cl	208-211		
41	H	Methoxy	CF <sub>3</sub>	178-180		
42	H	2-Fluoroethyl	Cl	100-103		
43	H	2-Fluoroethyl	CF <sub>3</sub>	132-134		

## List 1

44. 3-(4-Chlorophenyl)-N-methoxy-N'-((3-methylphenyl)sulfonyl)-4-phenyl-4,5-dihydro-1H-pyrazole-1-carboxamidine. MP: 151-152 °C.
45. 3-(4-Chlorophenyl)-N-methoxy-N'-((2-methylphenyl)sulfonyl)-4-phenyl-4,5-dihydro-1H-pyrazole-1-carboxamidine. MP: 145-146 °C.
46. 3-(4-Chlorophenyl)-N-methoxy-N'-((2,4,5-trifluorophenyl)sulfonyl)-4-phenyl-4,5-dihydro-1H-pyrazole-1-carboxamidine. MP: 160-162 °C.
47. 3-(5-Chlorothiophen-2-yl)-N'-((4-chlorophenyl)sulfonyl)-N-methoxy-4-phenyl-4,5-dihydro-1H-pyrazole-1-carboxamidine. MP: 180-181 °C.
48. N'-((4-Chlorophenyl)sulfonyl)-3-(4-fluorophenyl)-N-methoxy-4-phenyl-4,5-dihydro-1H-pyrazole-1-carboxamidine. MP: 201-203 °C.

49. 3-(4-Chlorophenyl)-N'-((4-chlorophenyl)sulfonyl)-N-methoxy-4-(3-(trifluoromethyl)phenyl)-4,5-dihydro-1H-pyrazole-1-carboxamide. MP: 80-83 °C.
50. 3-(4-Chlorophenyl)-N'-((4-chlorophenyl)sulfonyl)-N-methoxy-4-(2,6-difluorophenyl)-4,5-dihydro-1H-pyrazole-1-carboxamide. MP: 174-177 °C.
51. 3-(4-Chlorophenyl)-N'-((4-chlorophenyl)sulfonyl)-N-(2-fluoroethyl)-4-(2,6-difluorophenyl)-4,5-dihydro-1H-pyrazole-1-carboxamide. MP: 153-155 °C.
52. 3-(4-Chlorophenyl)-N'-((4-chlorophenyl)sulfonyl)-N-(2-fluoroethyl)-4-(3-fluorophenyl)-4,5-dihydro-1H-pyrazole-1-carboxamide. MP: 130 °C.
53. 3-(4-Chlorophenyl)-N-(2-fluoroethyl)-4-(3-fluorophenyl)-N'-((4-(trifluoromethyl)phenyl)sulfonyl)-4,5-dihydro-1H-pyrazole-1-carboxamide. MP: 155 °C.
54. 3-(4-Chlorophenyl)-N'-((4-chlorophenyl)sulfonyl)-4-(3-fluorophenyl)-N-(methoxy)-4,5-dihydro-1H-pyrazole-1-carboxamide. Amorphous.
55. 3-(4-Chlorophenyl)-4-(3-fluorophenyl)-N-(methoxy)-N'-((4-(trifluoromethyl)phenyl)sulfonyl)-4,5-dihydro-1H-pyrazole-1-carboxamide. MP: > 260 °C.
56. 3-(4-Chlorophenyl)-N'-((4-chlorophenyl)sulfonyl)-4-(2-fluorophenyl)-N-(methoxy)-4,5-dihydro-1H-pyrazole-1-carboxamide. MP: 162-164 °C.
57. 3-(4-Chlorophenyl)-4-(2-fluorophenyl)-N-(methoxy)-N'-((4-(trifluoromethyl)phenyl)sulfonyl)-4,5-dihydro-1H-pyrazole-1-carboxamide. MP: 147-149 °C.

In an analogous manner 29 compounds having formula (XII) were prepared. Those are listed below in table 2 and list 2.

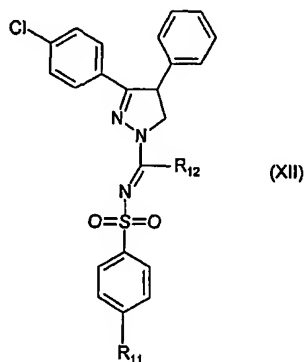


Table 2

Ex.	R <sub>11</sub>	R <sub>12</sub>	Melting point (°C)	MS ESI <sup>+</sup> (MH <sup>+</sup> )	Salt form
58	Cl	1,2,3,4-Tetrahydroisoquinolin-2-yl		589	
59	F	1,2,3,4-Tetrahydroisoquinolin-2-yl		573	
60	F	Pyrrolidin-1-yl		511	
61	Cl	Morpholin-4-yl		543	
62	F	Morpholin-4-yl		527	
63	Cl	Azetidin-1-yl	200-202	513	

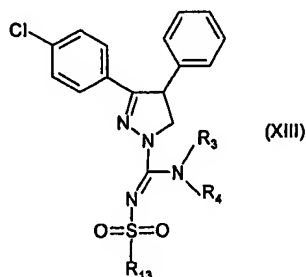
64	F	Azetidin-1-yl		497	
Ex.	R <sub>11</sub>	R <sub>12</sub>	Melting point (°C)	MS ESI <sup>+</sup> (MH <sup>+</sup> )	Salt form
65	Cl	4-Hydroxypiperidin-1-yl	112-117		
66	Cl	3-Hydroxypiperidin-1-yl	218-222		
67	Cl	4-(Hydroxymethyl)piperidin-1-yl	185-188		
68	Cl	1,1-Dioxythiomorpholin-4-yl	120	591	
69	Cl	4-Methylpiperazin-1-yl		556	
70	Cl	[1,4']-Bipiperidin-1'-yl	260	624	
71	Cl	3,5-Cis-dimethylpiperazin-1-yl			
72	F	4-Methylpiperazin-1-yl		540	
73	F	3,5-Cis-dimethylpiperazin-1-yl		554	
74	F	[1,4']-Bipiperidin-1'-yl	> 280	608	
75	F	4-Methyl-1,4-diazepan-1-yl	115	554	.HCl
76	Cl	1,4-diazepan-1-yl	84		
77	F	1,4-diazepan-1-yl			
78	Cl	2,6-Cis-dimethylpiperazin-1-yl	100 (dec.)		
79	F	4-(Dimethylamino)piperidin-1-yl	211-214		
80	F	Piperazin-1-yl	88-90		
81	Cl	4-(Pyridin-4-yl)piperazin-1-yl	224-226		
82	Cl	4-(2-Dimethylaminoethyl)piperazin-1-yl			
83	Cl	4-(3-Dimethylaminopropyl)piperazin-1-yl	163-165		
84	Cl	4-(3-Hydroxypropyl)piperazin-1-yl	> 140 (dec.)		
85	Cl	2,6-Cis-dimethyl-4-methylpiperazin-1-yl	75-80		

## List 2

86. N-[(3-(4-chlorophenyl)-4-(3-(trifluoromethyl)phenyl)-4,5-dihydro-1H-pyrazol-1-yl)(4-methylpiperazin-1-yl)methylene]-4-chlorobenzenesulfonamide. MP: 97-100 °C.

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In an analogous manner the compounds having formula (XIII) have been prepared. Those are listed in table 3 or detailed below:



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Table 3

Example	R <sub>3</sub>	R <sub>4</sub>	R <sub>13</sub>	Melting	MS ESI <sup>+</sup>
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				point (°C)	(MH <sup>+</sup> )
87	H	3-(Dimethylamino)propyl	CH <sub>3</sub>	136-138	
88	H	N-Methylpiperidin-4-yl	i-C <sub>3</sub> H <sub>7</sub>		

**Example 89****N-[(4-phenyl-3-(pyridin-3-yl)-4,5-dihydro-1H-pyrazol-1-yl)(4-methylpiperazin-1-yl)methylene]-4-fluorobenzenesulfonamide**

- 5 **Part A:** 3-Pyridyl benzyl ketone (Cf. Burger et al., J. Am. Chem. Soc. **1950**, 72, 1988-1990), (30.2 g, 0.153 mol) is dissolved in methanol (400 mL) and acetic acid (1.5 mL), piperidine (1.5 mL) and formaline (35 mL, 37 % aqueous solution) are successively added. The resulting mixture is heated at reflux temperature for 210 minutes. The resulting mixture is allowed to attain room temperature and concentrated *in vacuo*. Water and 2N NaOH solution are added, followed by
- 10 extraction with methyl-t-butyl ether (MTBE). The organic layer is twice washed with water, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered and concentrated *in vacuo*. Flash chromatographic purification (eluant: MTBE) gives 2-phenyl-1-pyridin-3-yl propenone (21.4 gram, 67 % yield) as an oil. ESI-MS (MH<sup>+</sup>) 210.
- 15 **Part B:** 2-Phenyl-1-pyridin-3-yl propenone (21.4 gram, 0.102 mol) is dissolved in ethanol (150 mL) and hydrazine hydrate is added (10.4 mL). The resulting mixture is heated at reflux temperature for 3 hours. The resulting mixture is allowed to attain room temperature and concentrated *in vacuo*. Water is added, followed by extraction with dichloromethane. The organic layer is washed with water, dried over Na<sub>2</sub>SO<sub>4</sub>,
- 20 filtered and concentrated *in vacuo* to produce crude 4-phenyl-3-(pyridin-3-yl)-4,5-dihydro-1H-pyrazole (23 g, ~100 % yield). ESI-MS (MH<sup>+</sup>) 224.
- Part C:** Crude 4-phenyl-3-(pyridin-3-yl)-4,5-dihydro-1H-pyrazole (9.81 g, 0.044 mol), [(4-chlorophenyl)sulfonyl]dithioimidocarbonic acid dimethyl ester (12.99 gram, 0.044 mol) and triethylamine (47 mL) are successively dissolved in acetonitrile. The
- 25 resulting mixture is heated at reflux for 70 hours. The resulting mixture is allowed to attain room temperature and concentrated *in vacuo*. The residue is dissolved in dichloromethane. The organic layer is washed with water, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered and concentrated *in vacuo*. Flash chromatographic purification (eluant: methanol/dichloromethane = 5/95 (v/v)) gives N-((4-chlorophenyl)sulfonyl)-4-phenyl-
- 30 3-(pyridin-3-yl)-4,5-dihydro-1H-pyrazole-1-carboximidothioic acid methyl ester (7.15 gram, 35 % yield). ESI-MS (MH<sup>+</sup>) 471.
- Part D:** N-((4-Chlorophenyl)sulfonyl)-4-phenyl-3-(pyridin-3-yl)-4,5-dihydro-1H-pyrazole-1-carboximidothioic acid methyl ester (1.50 gram, 0.0033 mol) is suspended in toluene (25 mL) and 4-methylpiperazine (5 mL) is added. The resulting mixture is
- 35 heated at 60 °C for 70 hours. The resulting yellow solution is allowed to attain room temperature and concentrated *in vacuo*. The resulting residue is crystallised from MTBE to give N-[(4-phenyl-3-(pyridin-3-yl)-4,5-dihydro-1H-pyrazol-1-yl)(4-methylpiperazin-1-yl)methylene]-4-fluorobenzene-sulfonamide (1.39 g, 83 % yield). MP: 169-170 °C.



Example 90

**(-)-(4S)-3-(4-Chlorophenyl)-N'-((4-chlorophenyl)sulfonyl)-N-methoxy-4-phenyl-4,5-dihydro-1H-pyrazole-1-carboxamide**

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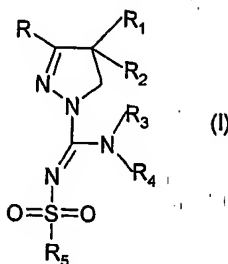
(-)-(4S)-3-(4-Chlorophenyl)-N'-((4-chlorophenyl)sulfonyl)-N-methoxy-4-phenyl-4,5-dihydro-1H-pyrazole-1-carboxamide ( $[\alpha]^{25}_D = -165^\circ$ ,  $c = 0.01$ , MeOH) was obtained as an amorphous solid *via* chiral chromatographic separation of racemic 3-(4-chlorophenyl)-N'-((4-chlorophenyl)sulfonyl)-N-methoxy-4-phenyl-4,5-dihydro-1H-

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pyrazole-1-carboxamide (Chiral stationary phase: Chiralpak AD). The mobile phase consisted of ethanol.

## Claims

1. Compounds of the general formula (I)



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wherein

- 10     - R and R<sub>1</sub> independently represent phenyl, thienyl or pyridyl which groups may be substituted with 1, 2, 3 or 4 substituents Y, which can be the same or different, from the group C<sub>1-3</sub>-alkyl or alkoxy, hydroxy, halogen, trifluoromethyl, trifluoromethylthio, trifluoromethoxy, nitro, amino, mono- or dialkyl (C<sub>1-2</sub>)-amino, mono- or dialkyl (C<sub>1-2</sub>)-amido, (C<sub>1-3</sub>)-alkyl sulfonyl, dimethylsulfamido, C<sub>1-3</sub> alkoxy carbonyl, carboxyl, trifluoromethylsulfonyl, cyano, carbamoyl, sulfamoyl and acetyl, or R and/or R<sub>1</sub> represent naphthyl,
- 15     - R<sub>2</sub> represents hydrogen, hydroxy, C<sub>1-3</sub>-alkoxy, acetyloxy or propionyloxy,
- 20     - R<sub>3</sub> represents a hydrogen atom or a branched or unbranched C<sub>1-8</sub> alkyl group or a C<sub>3-7</sub> cycloalkyl group which alkyl group or cycloalkyl group may be substituted with a hydroxy group,
- 25     - R<sub>4</sub> represents a C<sub>2-10</sub> branched or unbranched heteroalkyl group, C<sub>3-8</sub> non-aromatic heterocycloalkyl group or C<sub>4-10</sub> non-aromatic heterocycloalkyl-alkyl group which groups contain one or more heteroatoms from the group (O, N, S) or a -SO<sub>2</sub>- group, which C<sub>2-10</sub> branched or unbranched heteroalkyl group, C<sub>3-8</sub> non-aromatic heterocycloalkyl group or C<sub>4-10</sub> non-aromatic heterocycloalkyl-alkyl group may be substituted with a keto group, trifluoromethyl group, C<sub>1-3</sub> alkyl group, hydroxy, amino, monoalkylamino, or dialkylamino group or a fluoro atom,
- 30     or R<sub>4</sub> represents an amino, hydroxy, phenoxy or benzyloxy group, or R<sub>4</sub> represents a C<sub>1-8</sub> alkoxy, C<sub>3-8</sub> alkenyl, C<sub>5-8</sub> cycloalkenyl or C<sub>6-9</sub> cycloalkenylalkyl group which groups may contain a sulphur, nitrogen or oxygen atom, a keto group or -SO<sub>2</sub>- group, which alkoxy, alkenyl and cycloalkenyl groups may be substituted with a hydroxy group, a trifluoromethyl group, an amino group, a monoalkylamino group or dialkylamino group or a fluoro atom, or R<sub>4</sub> represents a C<sub>2-5</sub> alkyl group which alkyl group contains a fluoro atom, or R<sub>4</sub> represents an imidazolylalkyl group, benzyl, pyridylmethyl, phenethyl or thienyl group, or R<sub>4</sub> represents a substituted phenyl, benzyl, pyridyl, thienyl, pyridylmethyl or phenethyl group wherein the aromatic rings are substituted with 1, 2 or 3 of the substituents Y, wherein Y has the meaning as indicated above.
- 35

or when R<sub>3</sub> is H or methyl, R<sub>4</sub> may represent a group NR<sub>6</sub>R<sub>7</sub> wherein

- R<sub>6</sub> and R<sub>7</sub> are the same or different and represent C<sub>2-4</sub> alkyl, C<sub>2-4</sub> trifluoroalkyl or R<sub>6</sub> represents a methyl group with the proviso that R<sub>7</sub> represents a C<sub>2-4</sub> alkyl group, or R<sub>6</sub> and R<sub>7</sub> - together with the nitrogen atom to which they are bonded - form a saturated or unsaturated heterocyclic moiety having 4 to 8 ring atoms which heterocyclic moiety may contain an oxygen or sulphur atom or a keto group or -SO<sub>2</sub>- group or an additional nitrogen atom, which saturated or unsaturated heterocyclic moiety may be substituted with a C<sub>1-4</sub> alkyl group, or
- R<sub>3</sub> and R<sub>4</sub> together with the nitrogen atom to which they are bonded form a saturated or unsaturated, monocyclic or bicyclic heterocyclic moiety having 4 to 10 ring atoms, which heterocyclic moiety may contain one or more atoms from the group (O, N, S) or a keto group or -SO<sub>2</sub>- group, which moiety may be substituted with a C<sub>1-4</sub> alkyl, hydroxyalkyl, phenyl, thienyl, pyridyl, amino, monoalkylaminoalkyl, dialkylaminoalkyl, monoalkylamino, dialkylamino, aminoalkyl, azetidiny, pyrrolidinyl, piperidinyl or hexahydro-1H-azepinyl group,
- R<sub>5</sub> represents benzyl, phenyl, thienyl or pyridyl which may be substituted with 1, 2, 3 or 4 substituents Y, wherein Y has the meaning as indicated above, which can be the same or different, or R<sub>5</sub> represents C<sub>1-8</sub> branched or unbranched alkyl, C<sub>3-8</sub> alkenyl, C<sub>3-10</sub> cycloalkyl, C<sub>5-10</sub> bicycloalkyl, C<sub>6-10</sub> tricycloalkyl or C<sub>5-8</sub> cycloalkenyl or R<sub>5</sub> represents naphthyl.

and tautomers, prodrugs, stereoisomers and salts thereof.

2. Pharmaceutical compositions containing a pharmacologically active amount of at least one compound as claimed in claim 1 as an active component.
3. Method of preparing pharmaceutical compositions as claimed in claim 2 characterised in that a compound as claimed in claim 1 is brought in a form suitable for administration.
4. Use of a compound as claimed in claim 1 for the preparation of a pharmaceutical composition for the treatment of disorders involving cannabinoid neurotransmission.
5. Use as claimed in claim 4 characterised in that said disorders are psychiatric disorders such as psychosis, anxiety, depression, attention deficits, memory disorders, cognitive disorders, appetite disorders, obesity, addiction, appetite, drug dependence and neurological disorders such as neurodegenerative disorders, dementia, dystonia, muscle spasticity, tremor, epilepsy, multiple sclerosis, traumatic brain injury, stroke, Parkinson's disease, Alzheimer's disease, epilepsy, Huntington's disease, Tourette's syndrome, cerebral

5 ischaemia, cerebral apoplexy, craniocerebral trauma, stroke, spinal cord injury, neuroinflammatory disorders, plaque sclerosis, viral encephalitis, demyelination related disorders, as well as for the treatment of pain disorders, including neuropathic pain disorders, and other diseases involving cannabinoid neurotransmission, including the treatment of septic shock, glaucoma, cancer, diabetes, emesis, nausea, asthma, respiratory diseases, gastrointestinal disorders, gastric ulcers, diarrhoea and cardiovascular disorders.

10

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 02/10433

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 A61K31/415 C07D231/06 C07D401/12 A61K31/4155 C07D401/06

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C07D A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

EPO-Internal; WPI Data; PAJ, BEILSTEIN Data, CHEM ABS Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO 01 70700 A (SOLVAY PHARMACEUTICALS B.V) 27 September 2001 (2001-09-27) see the formula (i) definition for Aa the whole document	1-5
A	US 5 624 941 A (BARTH FRANCIS ET AL) 29 April 1997 (1997-04-29) the whole document	1-5
A	US 4 070 365 A (VAN DAALEN JAN JOHANNES ET AL) 24 January 1978 (1978-01-24) the whole document	1-5
	-/--	

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

22 November 2002

Date of mailing of the international search report

29/11/2002

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Scruton-Evans, I

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 02/10433

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>PERTWEE R G: "PHARMACOLOGY OF CANNABINOID RECEPTOR LIGANDS" CURRENT MEDICINAL CHEMISTRY, BENTHAM SCIENCE PUBLISHERS BV, BE, vol. 6, no. 8, August 1999 (1999-08), pages 635-664, XP000923352 ISSN: 0929-8673 cited in the application see page 641</p> <p>---</p>	1-5
A	<p>WO 00 46209 A (SANOFI SYNTHELABO ;BARTH FRANCIS (FR); CAMUS PHILIPPE (FR); MARTIN) 10 August 2000 (2000-08-10) the whole document</p> <p>-----</p>	1-5

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 02/10433

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